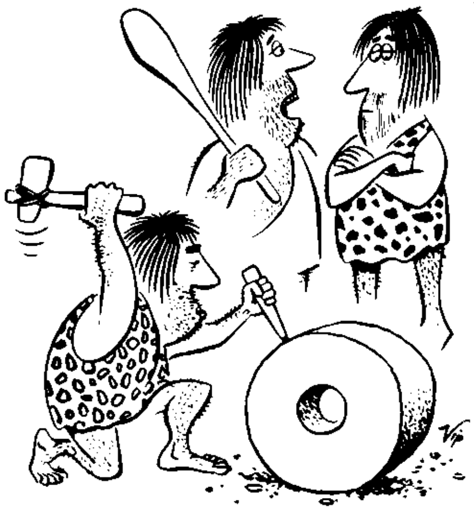
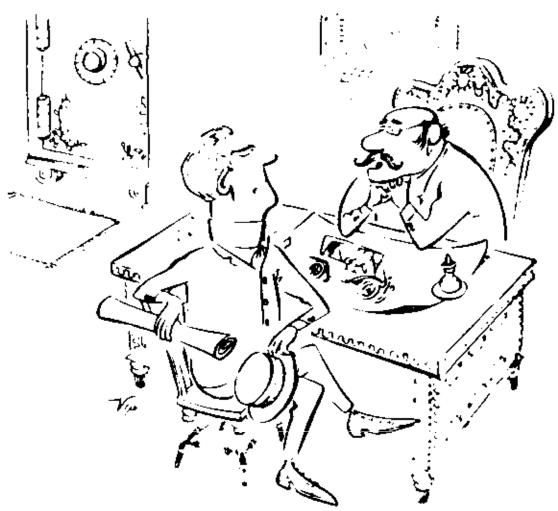
Chapter I

Summary—Issues and Options



' 'As a matter of fact, one of our tribe conceived the Idea of the wheel quite some time ago, but we reasoned that the speed of the outer circumference would be so much greater than the speed of the Inner circumference that the whole thing would fly apart. so we abandoned It "



"Do you realize. sir, that If your invention should gain popular acceptance–which I do not for one moment believe it will–we should have to provide paved roads, throughout the length and breadth of the country, thousands of pumping stations to supply ready access to fuel, and innumerable vacant lots In every city In which to park the vehicles? Take my advice and forget this folly, Henry "

''The whole business is economically unsound, gentlemen. With a train of this length and 40 miles of track. we find that only .0568 percent of the track will be in use at any given time. representing a constant idle investment of 99.9432 percent.''

Credit. Illustrations by Virgil Partch
SOURCE U S Steel Pub ADUSS No. 87-1811. December 1965

Photo credit: U.S. Environmental Protection Agency

Congestion: possible doubling by year 2000

Projected Daily Urban Travel and Congestion

	1975		1985		2000	
	Daily auto VMT (millions)	Percent occurring under congested conditions[1]	Daily auto VMT (millions)	Percent occurring under congested conditions	Daily auto VMT (millions)	Percent occurring under congested conditions
Interstate	288	10	[illegible]	15	[illegible]	[illegible]
Other freeways and expressways	170	11	[illegible]	15	[illegible]	[illegible]
Other principal arterials	465	15	[illegible]	21	[illegible]	[illegible]
Minor arterials	331	9	[illegible]	10	[illegible]	[illegible]
Collectors	150	5	[illegible]	7	[illegible]	16
Local	230	N/A	[illegible]	N.A.	[illegible]	N.A.
Total	1,634	10	[illegible]	14	[illegible]	[illegible]

VMT = [illegible]

[1] [illegible] occur when the ratio of traffic volume to road capacity is greater [illegible]

[illegible]

Chapter I

SUMMARY–ISSUES AND OPTIONS

Overview

Unless cities adopt forms of transportation that require less energy and space, they face a future of greatly increased traffic congestion and reduced mobility. Barring major policy changes, traffic congestion in cities is expected to double between 1975 and 2000. In addition, people dependent on public transportation will find it increasingly difficult to travel, particularly to dispersed suburban job centers where most of the employment growth is occurring.

Current transit options, conceived 50 or more years ago, are unable to serve efficiently the dispersed travel patterns in today's low-density urban areas. This growing mismatch between available transit services and trip demands largely explains why transit serves only 12 percent of the work trips and 2.5 percent of total urban trips (see table below). Transit's market share would need to increase dramatically to bring about a major reduction in traffic congestion and energy consumption.

Urban transportation problems do not lend themselves to a single all-encompassing solution. Several near- and long-term options have been identified, however, which offer the reasonable prospect of making these problems more manageable. These options include expanded use of carpools and vanpools, transportation system management techniques, land use policies, near-term transit product improvements, and new transit technologies offering service levels more competitive with the automobile.

Major Mode of Transportation to Work for 21 Standard Metropolitan Statistical Areas: 1975

Mode	Number (thousands)	Percent[a]
Workers using vehicles	*11,650*	100
Auto or truck	10,040	86
Drives alone	7,877	68
Carpool	2,100	18
Public transportation	1,432	12
Bus or streetcar	1,018	9
Subway or elevated	177	2
Railroad	224	2
Other (motorcycles and bicycles)	179	2

[a]Percent of workers using vehicles
NOTE Figures do not add due to rounding
SOURCE Data from the Travel to Work Supplement to the Annual Housing Survey

Automated guideway transit (AGT)—consisting of driverless vehicles operating on their own guideway—is widely regarded as a promising new option that cities should have the opportunity to select in addition to buses, subways, and trolleys. A wide variety of automated transit systems are undergoing development in the United States, Europe, and Japan. The simplest form, called shuttle-loop transit (SLT), has operated successfully for several years in shopping centers, airports, and amusement parks. SLT systems typically consist of single vehicles or vehicles in trains operating on short segments of linear or circular guideways with few stations, little or no vehicle switching, and at least 1-minute spacing or "headway" between vehicles. Most installations have been on elevated guideways, but some also operate at ground level or in tunnels. These types of systems are commonly referred to as horizontal elevators. The Urban Mass Transportation Administration (UMTA) has provided some research and development funding for SLT systems over the past decade and is now supporting planning activities in 10 cities for the installation of SLT systems in the downtown areas. This downtown people mover (DPM) program was created to test the viability of existing AGT systems as circulators in city centers.

A second generation of AGT systems called group rapid transit (GRT) is operating in Morgantown, W.Va., and at the Dallas-Fort Worth, Tex., airport. Both of these systems received Federal support. Compared to SLT systems, GRTs can operate at shorter headways (down to 3 seconds) on more extensive guideway networks and make much more extensive use of switching. GRT stations can be located on sidings called offline stations, which permit vehicles to bypass other vehicles that have stopped to accept or discharge passengers.

The most complex form of guideway transit is called personal rapid transit (PRT). These systems are characterized by small, one- to six-passenger vehicles, capable of operating at one-half to 3-second headways and offering nonstop origin-to-destination service on extensive, narrow guideways. As in the private automobile, PRT riders would not be required to share their vehicle with strangers. PRT has been under development in France, West Germany, and Japan, but no system has been deployed in cities.

A federally funded program is currently underway to develop a third generation of automated systems called advanced group rapid transit (AGRT). The largely arbitrary system specifications, as defined by UMTA, place AGRT on the dividing line between GRT and PRT systems. These specifications call for 40-mph, 12-passenger, all-seated vehicles operating with 3-second headways and offline stations. Three designs were selected including a rubber-tired vehicle with propulsion through the wheels, and two systems propelled by linear induction motors, one supported by an air cushion and the other magnetically levitated, The technologies under development in the AGRT program could be applied to all forms of exclusive guideway transit ranging from large-vehicle urban rail systems to small-vehicle PRT systems.

OTA was asked by the Transportation Subcommittee of the House Appropriations Committee to evaluate recently proposed changes in the scope and cost of the AGRT program. This assessment addressed three major issues.

Issue 1: The Need For More Advanced Automated Systems

Will AGRT offer significantly lower cost and superior service than other types of urban transit?

There is considerable support at the local level for continuing work on AGT technologies, both among transit users and public officials. Users and nonusers alike are critical of the amenities, frequency of service, reliability, crowding, and inconvenience characteristic of transit services currently available in most cities. Technological innovations encompassed in the AGRT program include new electronic control systems, linear induction motors, magnetic levitation systems, high-speed switching, and emergency braking for short headway operations. These advances in technology offer several potential benefits to transit operators and users:

- service flexibility comparable to vans or taxis coupled with the carrying capacity of a trolley car system or a multilane freeway,

Photo credit U S Department of Energy

Old technology—changing needs

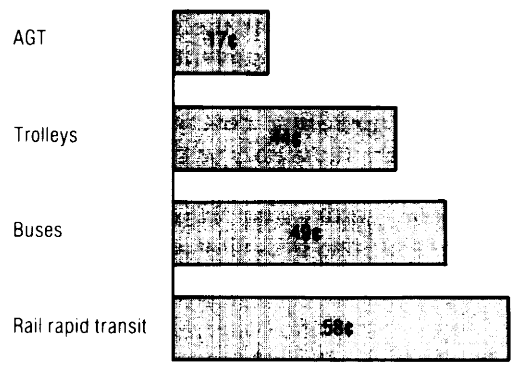
- lower cost per mile of guideway than for heavy-rail transit systems thus permitting the construction of more extensive guideway networks for a fixed capital investment,
- rapid origin-to-destination service with few or no intermediate stops and no transfers, and
- substantially increased frequency of non-rush hour service.

Systems incorporating these technologies could transport people and goods into activity centers as well as provide circulation within downtown and suburban activity centers. While there is widespread agreement that these changes in service levels would be beneficial, several potential problems have been identified that need to be more fully addressed:

- reliability of new technology;
- community acceptance of elevated guideway designs;
- evacuation of passengers stranded on narrow elevated guideways;
- operating problems in ice and snow;
- public resistance to riding small, automated vehicles in the company of strangers; and
- verification of 1ifecycle cost estimates.

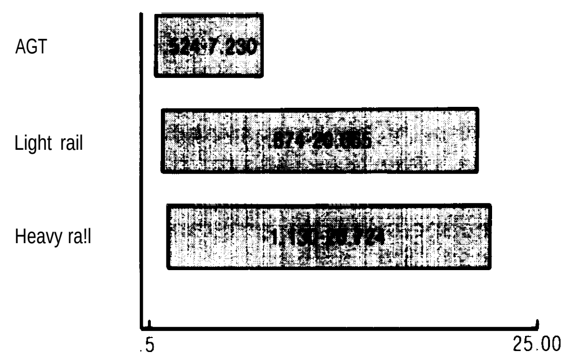
UMTA has sponsored studies that compare the capital and operating costs of AGRT with other transit options. The results show that there are great variations in cost from system to system which make generalized cost comparisons virtually meaningless. For example, operations and maintenance (O&M) costs per vehicle-mile for the **10** existing AGT systems range from $0.49 to $6.55. Average O&M costs per passenger-mile for AGT ($0.17) compare very favorably with trolleys ($0.44), buses ($0.49), and rail rapid transit ($0.58). However, the O&M costs per passenger-mile for AGT ranges from $0.09 to $1.01. Consequently, comparisons of average costs across broad categories of systems tend to be misleading. There are also wide variations in the capital costs of these systems which reflect site-specific differences in topography, guideway design, local labor rates, and system design requirements. More reliable comparisons need to be made through analysis of individual community requirements.

Average Operating and Maintenance Costs Per Passenger-Mile



SOURCE N D Lea & Associates Inc , Washington D C

Guideway Construction Costs, $/Lane-Mile (in millions of 1976 dollars)



SOURCES Thomas K Dyer Inc *Rail Rapid Transit Cost Study* March 1977 N O Lea & Associates Inc Summary of Capital and Operating and Maintenance Cost Experience of Automated Guideway Transit Systems June 1978

No reliable techniques exist for estimating ridership on such systems because they embody service characteristics presently unavailable on public transit. Until some actual operating experience is accumulated, claims about costs per passenger-mile on AGRT systems cannot be verified. Surveys show that the service attributes made possible by AGRT technologies are regarded favorably by the public. However, survey data is not always a reliable indication of future behavior. A limited test of these new service levels will be required to verify the survey findings.

In summary, we find that:

- AGRT technologies appear capable of providing service levels that the public wants but cannot get with currently available transit technologies.
- Capital and operating cost estimates for AGRT compare favorably with the costs of installing and operating heavy-rail systems on exclusive guideways. However, there are large variations in capital and operating costs among the 10 operational automated guideway systems. Precise comparisons with other transit technologies will require further testing of AGRT systems and real-world experience.
- Additional system optimization studies are needed to determine the preferred vehicle size, seating capacity, guideway configuration, headway; and line speed of future AGT systems. The views of transit operators and the public should play a central role in this analysis.

Issue 2: Prototype Development

Do the benefits to be gained from building more than one prototype technology justify the additional cost?

The original AGRT project plan called for three manufacturers to submit competing designs, followed by the selection of a single system for prototype development. This plan was later changed to provide for prototype development of both the air-cushion and the wheeled-vehicle systems. In the revised plan, work was also to continue on magnetic levitation technology, but at a lower level than for the other two systems. These changes, together with inflation adjustments, increased the program costs from $43.5 million to $111 million.

AGT technology is currently at a stage of development analogous to automobile technology shortly after the turn of the century. In the early years automobile technology was very diverse and a single-design concept did not emerge until after an extended period of testing in the marketplace. AGT is still in the early stages of its development cycle and it is too soon to predict which technology will prove superior in most applications.

In summary, we find that:

- Money invested in alternative AGRT technologies during the early phases of the R&D program can provide relatively inexpensive insurance against the risk of picking an inferior design.
- At this early stage in the development cycle, there is no sound technical basis for discontinuing work or providing any promising technology with significantly less funding. Magnetic levitation is a particularly promising option because of its low noise and high reliability potential.

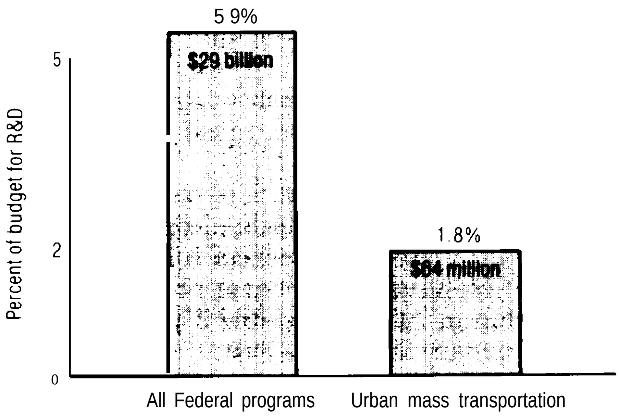
Issue 3: Government/Industry Relationships

What role should Government and industry play in the development of advanced AGT?

Federal programs established to foster the introduction of new transit technologies have consistently underestimated the complex institutional, economic, and technical barriers to innovation. Neither transit operators nor local public officials are anxious to volunteer their communities as laboratories for transit experiments unless the Federal Government is prepared to underwrite the financial risks of failure.

Potential transit system suppliers find it increasingly difficult to justify major corporate investments in transit innovation, given a history of uncertain Federal support, unrealistically tight development timetables, complex institutional barriers, and the lack of established stable markets. Unlike the automotive industry which caters to millions of customers, or the aircraft manufacturers who have established long-term relationships with scores of airlines worldwide,

Federal Government Spending Allocated to Research and Development–1979



SOURCES Office of Management and Budget U S Department of Transportation Urban Mass Transportation Admfmstral(on

the fate of would-be transit equipment suppliers is increasingly bound up with one customer—the Federal Government. Suppliers regard this as an inherently unstable and risky arrangement.

The transit procurement process continues to be administered at the local level. However, the amount of funding available to each city, the kinds of equipment that are eligible for purchase, and the procurement procedures themselves are largely determined at the Federal level. The supplier industry is generally skeptical that the Federal Government will either decontrol the transit procurement process or provide what they regard as sufficient funding to create a stable market for innovative transit technologies. Several firms are willing to participate in federally funded R&D programs that require no major corporate investments, but it is unlikely that production commitments will be made unless industry is reasonably confident of a favorable return on investment, even if Government agencies promise support for such a market.

Transit operators and local public officials are expressing growing concern that the products of these federally sponsored R&D programs fail to satisfy their transportation needs at reasonable costs. Denver, Cleveland, Houston, and St. Paul were all selected by the Federal Government as demonstration sites for an AGT system. All four cities have reportedly withdrawn from the program even though UMTA had agreed to pay 80 percent of the system acquisition costs. While many other cities have expressed an interest in deploying AGT, it remains to be seen how many will decide to implement their plans.

In West Germany and Japan the development of advanced AGT technologies has been supported through special agencies established to promote the development of products that are competitive in international markets. In this country, the transit R&D function is managed by the same agency that regulates and funds urban transportation systems. Although foreign countries lack the depth of operating experience with AGT that has been accumulated in the United States, they have been more successful in resisting pressures to rush new technologies into service before they are thoroughly tested, and they have followed a more orderly development process.

The West German Cabintaxi system, with characteristics very similar to the current AGRT design goals, is expected to be carrying passengers in a Hamburg demonstration by 1981. The current development timetable for U.S. AGRT systems suggest that they will not begin to carry passengers before 1990 even if development and deployment hurdles are overcome. If the Cabintaxi demonstration is successful, it would be a clear signal that technological leadership has shifted overseas. The trade implications of such a development will depend on future U.S. Government policy toward advanced transit development and deployment.

In summary, we find that:

- Introduction of innovative transit systems is constrained not only by the need to more adequately develop the technology, but by major institutional and economic barriers as well.
- Recent experience suggests that the promise of 80-percent Federal funding is no longer sufficient inducement for cities to accept transit technologies if there is a question relative to whether they will meet local needs at a reasonable cost.

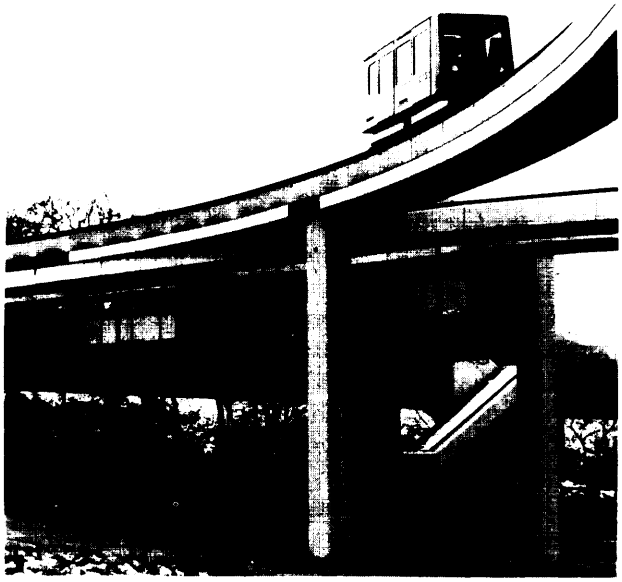


Photo credit DEMAG Fordertechnik

West German AGRT to enter service in 1981—9 years ahead of U.S. version

- Both West Germany and Japan have fostered a cooperative relationship between Government and industry that has helped ensure an orderly program of long-range transit innovation. Further consideration is needed of alternative institutional arrangements for managing transit R&D in the United States.
- The potential of broad international leadership in the transit technology field is no longer a credible prospect for U.S. industry. However, component or system leadership in AGT is possible if pursued more effectively than in the past.

Policy Options

Four options for continued research on AGT have been identified. These options are as follows:

1. **emphasize short= run product improvements in operating shuttle-loop and group rapid transit systems;**
2. **continue long-range development of critical new subsystems capable of providing major cost and service improvements;**
3. **validate new subsystems in a system environment to ensure that they perform acceptably as part of an integrated package; and**
4. **develop prototype systems that incorporate major new technologies leading to early deployment in cities.**

These options could be adopted either singly or in combination. For example, the first option emphasizes incremental improvements in shuttie-loop and group rapid transit systems that are already in operation. Examples of product improvements might include higher line speeds, larger motors, and more reliable door mechanisms. This upgrading of operational systems could be pursued as a short-range R&D objective alongside longer range transit innovations such as those encompassed in the AGRT program. Depending on the scope of a given product improvement program, the cost for each system could be expected to fall in the range of $2 million to $7 million. The major advantage of this option is that improvements are available to cities in the near-term. But if short-term objectives are pursued to the exclusion of long-range R&D options, major cost and service level improvements would be indefinitely postponed and the AGRT contractors would discontinue work on advanced systems.

Options 2 and 3 would continue development of technologies associated with the AGRT program but incorporate more flexibility in the selection of system design and performance specifications. To achieve the advances in service levels specified in the AGRT program each of the new subsystems needs to be developed in parallel and tested in a systems environment. It would be of little value, for example, to increase a vehicle's line speed to 40 mph unless it could be simultaneously demonstrated that the vehicle can be safely switched at these speeds, that the emergency braking systems are effective, and that the control systems are capable of maintaining safe stopping distances. It is not necessary, however to build full production prototypes to verify that the technology meets its design goals. Deferring development of production prototypes, however, will delay the deployment of these new technologies. Pursuing both Options 2 and 3 would cost in the range of $60 million to $80 million.

Option 4 would proceed immediately with the design and development of production prototypes. This was essentially the AGRT program as requested by UMTA in the FY 1979 budget at a cost of $111 million. Early in 1979, UMTA scaled down these plans. While work is to continue on the wheeled vehicle and air suspension systems together with a lower level effort on magnetic levitation, a decision to develop prototypes has been deferred. This option involves the highest cost and technological risk. Its major strength is that it aims at achieving the AGRT program goals in less time than it will take under Options 2 and 3.

In summary, we find that:

- Updating existing technologies (Option 1) should be a continuing objective of short-range transit R&D programs. But a short-range program is not a substitute for a long-range program aimed at achieving significant improvements in performance, cost, and service levels—beyond those achievable through incremental improvements in existing transit systems.
- Continued work on critical AGRT subsystems and their validation in a systems environment (Options 2 and 3) should help ensure the orderly development of new transit systems with improved operating characteristics. Emphasis on these two options appears to be most appropriate at this time.
- A decision to proceed immediately to develop one or more production prototype systems (Option 4) presupposes a base of knowledge about the relative merits of the technological options and their marketability which does not currently exist, Selecting specific prototype designs at this time would appear to be premature.

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